2005 Annual Monitoring and Maintenance Report

Burlington Northern Livingston Shop Complex
Livingston, Montana

BNSF Railway Company

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Kennedy/Jenks Consultants

2005 ANNUAL MONITORING AND MAINTENANCE REPORT
Burlington Northern Livingston Shop Complex
Livingston, Montana

Prepared for

BNSF RAILWAY COMPANY

Prepared by

KENNEDY/JENKS CONSULTANTS
ENGINEERS AND SCIENTISTS
32001 32nd Avenue South, Suite 100
Federal Way, Washington 98001
(253) 874-0555

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1.0 INTRODUCTION

This *2005 Annual Monitoring and Maintenance Report* has been prepared by Kennedy/Jenks Consultants on behalf BNSF Railway Company (BNSF) for the Burlington Northern Livingston Shop Complex (Facility) (see Figure 1) in accordance with "Subtask 18: Monitoring and Maintenance Report" of the *Statement of Work for Spring 2005 Activities* [Montana Department of Environmental Quality (DEQ) 2005c] (Spring 2005 SOW) dated June 2005.

A summary of work performed during 2005 associated with the Spring 2005 SOW is provided in Table 1. Only one remedial design/remedial action (RD/RA) task (Task C: Cinder Pile Capping) required post-remedial action monitoring and maintenance during 2005.

Monitored natural attenuation (MNA) is the selected remedy for dissolved volatile organic compounds (VOCs) and petroleum hydrocarbons in groundwater at the Facility. According to the Spring 2005 SOW and subsequent guidance from DEQ, this remedy is to include quarterly and/or semiannual monitoring (or other DEQ-approved sampling frequency) of selected wells to obtain data for evaluating concentration trends and developing a long-term monitoring strategy for the Facility.

Interim semiannual groundwater monitoring continued during 2005 as approved by DEQ. DEQ's approval of the groundwater monitoring programs presented in remedial action plans and/or supplemental investigation work plans for the following RD/RA tasks will replace this semiannual monitoring in the future:

- Task F: Alluvial Aquifer Groundwater VOC Cleanup
- Task G: Groundwater Dissolved Phase Petroleum Cleanup
- Task L: Investigation of VOCs in Bedrock Aquifer(s).

2.0 TASK C: CINDER PILE CAPPING

2.1 WORK PERFORMED

Information required in the annual monitoring and maintenance report regarding Task C has been provided to DEQ in the *Draft Cinder Pile Remedial Action Report, Livingston Rail Yard, Montana* prepared by Envirocon, Inc. of Missoula, Montana dated October 2005 (Envirocon 2005b). The *Draft Cinder Pile Remedial Action Report* includes the following:

- Description of work performed
- General field observations
- Discussion of quality assurance/quality control (QA/QC)
- Deviations from work plan
- Institutional controls
- Verification of compliance with environmental requirements, criteria, and limitations (ERCLs)
- Conclusions on design implementation success
- Recommendation for follow-up actions
- Table summarizing the test results for cap import material

- Figures showing pre-construction cinder pile surface, re-contoured subgrade before capping, cap final surface, surface cross-sections (pre-construction, final subgrade, and final cap), traffic routing, and schematic fence design

- Appendices including notification to DEQ Permitting and Compliance Division that cinder pile may contain asbestos-containing material (ACM), draft post-construction maintenance/monitoring plan, stormwater pollution prevention plan (SWPPP), Notice of Intent (NOI) form and DEQ's letter confirming receipt, DEQ approval of subgrade, asbestos permit application and worker certifications, supplier certification of clean import materials, seed weed-free certification, photographs, weed control plan with approval, asbestos air monitoring results, and project field logs.

This report was submitted to DEQ on 13 October 2005 for review and approval. DEQ approval of this document is pending. Since the relevant information required for the annual monitoring and maintenance report regarding Task C has already been provided to DEQ in this comprehensive report, the information is not repeated in this Annual Monitoring and Maintenance Report.

2.2 MONITORING AND MAINTENANCE

2.2.1 Quarterly Inspections

Quarterly inspections of the cinder pile were conducted on 30 July 2005 and 25 October 2005 and documented on a cinder pile inspection form. (Note: At the time of the 30 July 2005 inspection, the inspection form was still in draft format.) During the October 2005 inspection, one noxious weed species (Canadian Thistle) was identified in the southeastern corner of the cinder pile. The noxious weed was removed in November 2005. Cinder pile inspection forms are included in quarterly status.

2.2.2 Future Monitoring and Maintenance

Future inspections are tentatively scheduled as follows:

- Mid-late April 2006 (fourth quarterly)
- Mid July 2006 (first semiannual – after spring runoff and mow vegetation)
- Mid-late August 2006 (second semiannual – late summer)
- Late June 2007 (first annual, i.e. third year – after spring runoff)
- Late June 2009 (second annual, i.e. third year – after spring runoff).

Cap maintenance will be conducted as required based on the inspections. It is anticipated that ongoing monitoring and maintenance requirements for the cinder pile will be addressed under the Livingston Statement of Work (SOW).

3.0 INTERIM GROUNDWATER MONITORING

3.1 WORK PERFORMED

Interim semiannual groundwater monitoring events were conducted at the Facility in June and November 2005 in general accordance with the *Draft Statement of Work Remedial Design/Remedial Action* (Tetra Tech 2002) and subsequent direction by DEQ. Additional wells have also been added to the monitoring program at the request of BNSF. One additional sampling event was conducted in March 2005 at the request of BNSF in support of *Task G Stage I Remedial Action Plan for Dissolved Phase Petroleum Hydrocarbons in Groundwater* (Kennedy/Jenks Consultants 2005e). Interim groundwater sampling locations are shown on Figure 2.

Table 2 provides a summary of the wells included in each monitoring event. Groundwater samples collected at the Facility in June and November 2005 were collected using the low-flow purge and sample procedures as outlined in following correspondence, unless otherwise stated:

- Request to Modify Purging and Sampling Methodology for Groundwater Sampling, BN Livingston Shop Complex Facility, Livingston, Montana prepared by Kennedy/Jenks Consultants dated 1 February 2005 (Kennedy/Jenks Consultants 2005b).

- Groundwater Sampling in Support of Task G of Statement of Work for Spring 2005 Activities, BN Livingston Shop Complex, Livingston, Montana prepared by Kennedy/Jenks Consultants dated 24 February 2005 (Kennedy/Jenks Consultants 2005c).

- Modified Groundwater Sampling Procedures for BN Livingston Shop Complex Facility prepared by DEQ dated 20 May 2005 (DEQ 2005b).

- June 2005 Groundwater Monitoring/Groundwater Sampling Procedures, BN Livingston Shop Complex Facility, Livingston, Montana prepared by Kennedy/Jenks Consultants dated 1 June 2005 (Kennedy/Jenks Consultants 2005f).

(Note: Approximately three casing volumes were purged from the wells sampled in March 2005 prior to sample collection as low-flow purge and sample procedures had not yet been approved by DEQ.)

During purging, water quality parameters including temperature, pH, specific conductance, dissolved oxygen (DO), oxidation-reduction (redox) potential (ORP), and turbidity were measured and recorded at regular intervals until water quality parameters stabilized. (Note: Turbidity was not measured during the March 2005 monitoring event.) Groundwater samples were collected post-purge, unless otherwise stated. Copies of the groundwater purge and sample forms for each monitoring event are included in Appendix A.

One domestic well (Rainbow) was sampled during the June 2005 monitoring event. The cold-water tap closest to the wellhead was opened to the maximum extent possible, and water was allowed to flow for several minutes to flush the upstream piping. During purging, water quality parameters including temperature, pH, specific conductance, DO, and ORP were measured and recorded at regular intervals. Flushing was continued until at least three consecutive measurements for temperature, pH, and specific conductance stabilized. After stabilization, the flow rate was reduced to approximately 0.1 to 0.3 liter per minute (L/m) for sample collection. During the November 2005 monitoring event, a grab groundwater sample was collected from domestic well 12R03 at the request of DEQ. This well could not be pumped prior to sample collection due to access limitations and well configuration. A grab groundwater sample was collected from the well using a bailer.

Samples were collected in pre-preserved (where applicable) laboratory-supplied sample containers for the intended analyses. When filled, the bottles were labeled and

packaged in a cooler with enough ice to maintain the sample temperature at approximately 4 degrees Celsius (^{o}C). Sampling personnel documented each sample, the date and time of collection, and required analyses on the chain-of-custody form. Groundwater samples were shipped under chain-of-custody protocol to North Creek Analytical, Inc. (NCA) in Bothell, Washington for analysis. (Note: Analysis of groundwater samples by EPA Method 524.2 was conducted by NCA's Beaverton, Oregon laboratory, which is accredited by the State of Montana to perform EPA Method 524.2.)

Table 3 provides a summary of sample collection dates, purging/sampling equipment (i.e., peristaltic, dedicated bladder pump, bailer), analyses performed, and associated analytical test methods for groundwater samples collected in 2005.

Purge water generated during each monitoring event was treated by a granular activated carbon (GAC) filter. The treated water was stored in a secured area and was managed in accordance with the *Revised Investigation-Derived Residual Water Treatment Plan, Burlington Northern Livingston Shop Complex Facility* (Kennedy/Jenks Consultant 2005a) (see Section 5.0). This treatment plan was approved by DEQ in their letter dated 14 February 2005 (DEQ 2005a).

DEQ was notified in advance of each monitoring event in letters dated 24 February 2005, 8 June 2005, and 28 October 2005. A DEQ employee or contractor (i.e., Camp, Dresser & McKee) was present during each monitoring event.

3.1.1 March 2005 Monitoring Event

The Spring 2005 SOW provided the option for BNSF to perform additional sampling to assess dissolved-phase petroleum hydrocarbon concentrations and indicators of natural attenuation in alluvial aquifer groundwater in the Former Depot Refueling and Former Freight Train Refueling Areas and support the development of dissolved-phase

petroleum hydrocarbon concentration distribution mapping for alluvial aquifer groundwater at the Facility.

Groundwater samples were collected from the following wells during the March 2005 monitoring event:

- L-87-1, L88-9, LS-6, LS-9, LS-10, LG-4, LG-5, LG-12, and LG-13 – located in the Former Depot Refueling Area (see Figure 2)

- L-87-6, HRO-23, and RW-8 – located in Former Freight Train Refueling Area (see Figure 2).

Wells LG-2 and LG-3 (located in the Former Depot Refueling Area) were identified in the notification letter for groundwater sampling, but were not accessible at the time of sampling. These two wells were covered with asphalt pavement. Well LG-11 (located in the Former Depot Refueling Area) was identified in the notification letter for groundwater sampling, but was dry at the time of sampling. Well RW-9 was also identified in the notification letter for groundwater sampling. Adjacent well HRO-23 (which is a 2-inch diameter well) was substituted for well RW-9 (which is a 6-inch diameter well) to reduce the volume of investigation-derived residual (IDR) water generated during purging of three casing volumes. In addition, no sample was collected from well L-87-7, located in the Former Freight Train Refueling Area, because a light non-aqueous phase liquid (LNAPL)-free groundwater sample could not be collected.

Groundwater samples were collected between 8 and 11 March 2005. In total, 13 groundwater samples, one field duplicate sample, and five trip blank samples were submitted to NCA for the following analyses:

- Extractable petroleum hydrocarbon (EPH) screen by EPA Method 8015. (Note: The EPH screening method is a screening technique for EPH analysis via the Montana Method.) If the EPH concentration exceeded the screening value of 0.300 milligrams per liter (mg/L), the sample was further fractionated by the

Massachusetts Department of Environmental Protection (MADEP 2004a) EPH Method. [Note: Two samples exceeded the screening value of 0.300 mg/L; one of these samples was also analyzed for polynuclear aromatic hydrocarbons (PAHs) by EPA Method 8270 with selective ion monitoring (SIM).]

- Volatile petroleum hydrocarbon (VPH) by the MADEP VPH Method [including methyl-tert-butyl ether, benzene, toluene, ethylbenzene, xylenes, and naphthalene (collectively referred to as MBTEXN)] (MADEP 2004b).

- Natural attenuation parameters including:
  - Nitrate+nitrite by EPA Method 353.2
  - Ammonia by EPA Method 350.3
  - Sulfate by EPA Method 300.0
  - Dissolved iron by EPA Method 200.7
  - Sulfide and ferrous iron by a Hach kit in the field.

(Note: A pre-purge sample was collected from well RW-8 during the March 2005 monitoring event for EPH and VPH analyses to allow comparison of data collected pre- and post-purge.)

Samples collected in March 2005 for natural attenuation parameters were collected based on ORP measurements obtained while purging the well. If the ORP reading remained stable during purging, samples for natural attenuation parameters were collected after purging the well. However, if the ORP reading began to change significantly while purging, samples for natural attenuation were collected prior to finishing purging so that potential sample agitation/aeration would not adversely affect redox-sensitive parameters. Samples from wells L-87-1, L-87-6, LG-12, LS-6, LS-10, and RW-8 were collected for natural attenuation parameters prior to completion of purging; all other samples were collected for natural attenuation parameters after purging the well.

Samples collected for analysis of dissolved iron were field filtered with a 0.45 micron filter. Samples collected for fielding testing of sulfide and ferrous iron using a Hach kit were also field filtered prior to analysis.

3.1.2 June 2005 Monitoring Event

Semiannual groundwater monitoring was conducted at the Facility in June 2005 during a period of seasonal high water table conditions. Sampling personnel attempted to measure the water levels and LNAPL thickness and to collect groundwater samples from scheduled wells, and additional wells requested by DEQ and BNSF. Wells included in the sampling network are shown on Figure 2. Wells where water level and LNAPL thickness measurements were taken are shown on Figure 3. As noted in Table 2, changes to the June 2005 monitoring event included the following:

- Monitoring well L-87-8 was not sampled due to the presence of measurable LNAPL (see Figure 2).

- Two samples were collected from monitoring well L-87-3 for VOC analysis (see Figure 2). At the request of DEQ, a second sample was collected at well L-87-3 (identified as L-87-3 P) using a peristaltic pump. (Note: The primary sample was collected using a dedicated bladder pump.)

- Domestic wells B-Street and Rainbow and monitoring well RW-5 were all inaccessible to be measured for water level and LNAPL thickness (see Figure 3). The B-Street and Rainbow wells could not be accessed due to the pump inside the well, and associated piping and electrical equipment at the well head that could not be removed and prevented access for water level/LNAPL thickness measurements. Well RW-5 could not be accessed with DEQ's concurrence because confined space entry would have been required.

- Monitoring well 89-8 was added to the June 2005 monitoring event as requested by BNSF and approved by DEQ (see Figure 2). This well was measured for water level and LNAPL thickness and sampled for VOC analysis, and methane, ethane, and ethene and dissolved organic carbon (DOC) analyses.

- Monitoring wells HR-2W and HR-2D were measured for water level and LNAPL thickness in June 2005 as requested by BNSF and approved by DEQ (see Figure 3).

- Monitoring wells L-87-2, L-87-3, L-87-5, LS-11, 89-3, 89-4, 89-9, 89-10, 90-3, 92-1, and 92-4 were also sampled for methane, ethane, and ethene and DOC analyses as requested by BNSF and approved by DEQ (see Figure 2).

Groundwater samples were collected between 24 and 27 June 2005. In total, 23 groundwater samples, one field duplicate sample, and three trip blank samples were submitted to NCA for analysis of VOCs by EPA Method 524.2 or 8260 (see Table 3). (Note: EPA Method 8260 is comparable to EPA Method 624 and was requested because NCA does not perform the latter method.) As stated above, 12 of the groundwater samples were also analyzed for methane, ethane, and ethene by RSK 175 and DOC by EPA Method 415.1.

3.1.3 November 2005 Monitoring Event

Semiannual groundwater monitoring was conducted at the Facility in November 2005 during a period of lower water table conditions. Sampling personnel attempted to measure the water levels and LNAPL thickness and to collect groundwater samples from scheduled wells, and additional wells requested by DEQ and BNSF. Wells included in the sampling network are shown on Figure 2. Wells where water level and LNAPL thickness measurements were taken are shown on Figure 4. As noted in Table 2, changes to the November 2005 monitoring event included the following:

- L-87-8 was not sampled due to the presence of measurable LNAPL (see Figure 2).

- Well 94-1 could not be accessed for water level and LNAPL thickness monitoring or groundwater sampling as the property had been sold and the new property owner was not available to grant access at the time of monitoring (see Figure 2).

- Domestic wells B-Street and Rainbow and monitoring well RW-5 were all inaccessible to be measured for water level and LNAPL thickness (see Figure 4). The B-Street and Rainbow wells could not be accessed due to the pump inside the well, and associated piping and electrical equipment at the well head that could not be removed and prevented access for water level/LNAPL thickness measurements. Well RW-5 could not be accessed with DEQ's concurrence because confined space entry would have been required.

- Monitoring well 89-8 was added to the November 2005 monitoring event as requested by BNSF and approved by DEQ (see Figure 2). This well was measured for water level and LNAPL thickness and sampled for methane, ethane, and ethene and DOC analyses.

- One domestic well (12R03) was added to the November 2005 monitoring event as requested by DEQ (see Figure 2). This well was sampled for VOC analysis.

Groundwater samples were collected between 16 and 18 November 2005. In total, 12 groundwater samples, one field duplicate sample, and three trip blank samples were submitted to NCA for analyses (see Table 3). Eleven samples were analyzed for VOCs. Samples collected from wells 94-2 and 12R03 were analyzed for VOCs using EPA Method 524.2; the remaining nine samples were analyzed for VOCs using EPA Method 8260. The sample from well 89-8 was analyzed for methane, ethane, and ethene by RSK 175 and DOC by EPA Method 415.1.

3.1.4 QC Sampling

QC samples submitted for analysis during each monitoring event included field duplicate samples and trip blank samples (as indicated in the previous sections above). During the March, June, and November 2005 monitoring events, field duplicate samples were collected at a rate of 8, 4, and 8 percent, respectively. The duplicate samples were collected at the same time as primary samples by filling two sets of sample bottles and then assigning a fictitious sample identification number to the duplicate sample. Trip blank samples, which were prepared by the laboratory using de-ionized water, were also submitted with each cooler for analysis of either VOCs or VPH. The trip blank samples were prepared at the time bottles were ordered and accompanied bottles and sample shipments throughout each monitoring event.

3.1.5 DEQ Split Samples

DEQ collected split samples from wells 89-4 and 89-8 during the June 2005 monitoring event. The split samples were analyzed for VOCs by Energy Laboratories, Inc., of Helena, Montana using EPA Methods 8260 (89-4) and 524.2 (89-8).

3.2 GENERAL FIELD OBSERVATIONS

Field measurements collected during the 2005 monitoring events included water levels and LNAPL thicknesses and water quality parameters. Prior to commencing any sampling, wells throughout the Facility were visited and water level and LNAPL thickness measurements were recorded. These pre-sampling measurements are included in Tables 4 and 5. (Note: The groundwater purge and sample forms also include a water level measurement taken immediately prior to the start of purging and may differ slightly from the measurement recorded in Tables 4 and 5, due to the time-lapse between measurements.) Water quality parameters are recorded on the groundwater purge and sample forms included in Appendix A.

[Note: The March 2005 monitoring event was focused on obtaining data to assess dissolved-phase petroleum hydrocarbon concentrations and indicators of natural attenuation in alluvial aquifer groundwater in the Former Depot Refueling and Former Freight Train Refueling Areas and did not include a Facility-wide monitoring of water levels and LNAPL thicknesses. Although water levels and LNAPL thicknesses were measured in wells sampled in March 2005 as part of the groundwater sampling protocol (refer to groundwater purge and sample forms in Appendix A), these measurements were not tabulated or included with the historic water level and LNAPL thickness data for the Facility.]

3.2.1 Water Level and LNAPL Thickness Measurements

Prior to conducting groundwater sampling in June and November 2005, a round of groundwater and LNAPL thickness measurements were obtained from scheduled wells (see Table 2) in as short a time period as possible prior to initiating sampling. During the June 2005 monitoring event, water levels and LNAPL thicknesses were measured at 58 wells, including those wells requested for monitoring by the DEQ and BNSF on 22 and 23 June 2005. During the November 2005 monitoring event, water levels and LNAPL thicknesses were measured at 56 wells on 14 and 15 November 2005 (Note: Water level in domestic well 12R03 was measured on 18 November 2005.)

At each well, the cap was removed and the well was left open for several minutes to allow the water level to stabilize. An electronic, oil/water interface probe (Solinst® Interface Probe and/or a Heron® H.01L Interface Meter) was then slowly lowered into the well casing until contacting groundwater or LNAPL. The depth of the top of each fluid was measured and recorded to the nearest 0.01 foot using a surveyed mark on the top of the well casing.

After use at each well, the oil/water interface probe was decontaminated using a solution of phosphate-free detergent, potable water, and distilled water.

3.2.2 Groundwater Elevation, Flow Direction, and Gradient

Static groundwater depth measurements and calculated air-water table elevations for the June and November 2005 monitoring events are summarized in Tables 4 and 5, respectively. The air-water table elevations were calculated for monitoring wells containing LNAPL by multiplying the LNAPL thickness by a density factor of 0.88 and adding the result to the measured water-LNAPL table elevation.

Water table elevations measured in June 2005 ranged from 4,445.45 to 4,483.87 feet above mean sea level (msl) (wells 94-1 and L-88-9), respectively). As shown on Figure 3, the apparent groundwater flow direction in June 2005 was northeasterly on both sides of the Yellowstone River. The average hydraulic gradient was estimated to be 0.003 feet per foot (ft/ft).

Water table elevations measured in November 2005 ranged from 4,450.88 to 4483.22 feet msl (wells 94-2 and L-88-9, respectively). Water tables elevations were between 0.25 and 4.38 feet lower than the water table elevations measured in June 2005 (except for well RW-3 which was 0.05 foot higher). The largest variations in water table elevations (over 4 feet) were observed in wells 90-3 and 92-2 located closest to the Yellowstone River. As shown on Figure 4, the groundwater flow direction and gradient in November 2005 were similar to the flow direction and gradient observed in June 2005.

Groundwater elevations, flow directions, and gradients observed in 2005 are consistent with previous monitoring events.

3.2.3 LNAPL Thickness

The LNAPL thickness measurements for the June and November 2005 monitoring events are summarized in Tables 4 and 5, respectively. Historical LNAPL thickness

measurements recorded between May 1989 and November 2005 are summarized in Table 6. LNAPL thicknesses measured during 2005 are consistent with previous results.

LNAPL measurements for the June 2005 monitoring event, summarized in Table 4 and depicted on Figure 5, show that 12 wells (including L-87-8) contained measured LNAPL thicknesses ranging from <0.01 to 0.54 feet. The greatest measured LNAPL thickness was 0.54 feet in well RW6.

LNAPL measurements for the November 2005 monitoring event, summarized in Table 5 and depicted on Figure 6, show that 17 wells contained measured LNAPL thicknesses ranging from <0.01 to 1.43 feet. Nine of these wells had less than 0.05 foot of apparent LNAPL thickness. Well RW-6 contained the greatest measured LNAPL thickness of 1.43 feet.

The “apparent” LNAPL thickness is the length of the vertical column of LNAPL measured in a well. Between the June and November 2005 monitoring events, the apparent LNAPL thicknesses changed in the monitoring wells. The apparent LNAPL thickness measured in a well reflects the difference between the elevations of the air-LNAPL and the water-LNAPL tables at that monitoring point. These table elevations define the three phase capillary pressure distributions (i.e., LNAPL, water, and air) within the zone monitored. Seasonal water table fluctuations change the three phase capillary pressure distributions, which are reflected by changes in the air-LNAPL and the water-LNAPL table elevations. Hence, most changes in apparent LNAPL thickness in wells observed at the Facility are likely due to natural water table elevation fluctuations as opposed to changes in the LNAPL specific volume present in the formation at the point monitored (i.e., migration of additional LNAPL to the location monitored). This conclusion is made considering that the LNAPL saturation levels in the system are expected to be relatively constant due to the amount of time since the LNAPL entered the system and the relatively static nature of the LNAPL zones. Sudden increases in the LNAPL thickness are not expected because conditions at the Facility have had many years to reach steady state. Continued monitoring is appropriate to verify whether these changes are persistent or ephemeral.

3.2.4 Water Quality Parameters

During groundwater purging and sampling in March, June, and November 2005, water quality parameters were monitored and recorded at each well. An YSI 6820 Multi Probe System® was used to measure temperature, pH, specific conductance, DO, ORP, and turbidity (Note: Turbidity was not measured during the March 2005 monitoring event.) Parameter values were recorded during purging until parameter readings stabilized. The water quality measurements were recorded on the groundwater purge and sample forms that are provided in Appendix A and are summarized in Tables 7 through 9. In general, water quality parameters were consistent with previous results.

3.3 LABORATORY ANALYTICAL RESULTS

Analytical results from the March, June, and November 2005 monitoring events are summarized in Tables 10 through 15. These tables include historic analytical results as well as results from the 2005 monitoring events. *Record of Decision* (ROD) (DEQ 2001) cleanup or screening levels are shown in each table. [Note: The ROD cleanup levels for petroleum hydrocarbons are based on risk-based screening levels (RBSLs) in *Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases*, dated March 2000 (DEQ 2000). Since the ROD was issued in 2001, the Tier 1 RBSLs have been updated. The most recent Tier 1 RBSLs dated October 2003 (DEQ 2003) are shown in the tables. The ROD cleanup levels for VOCs and PAHs are based on *Circular WQB-7, Montana Numeric Water Quality Standards* (WQB-7 standards) dated September 1999 (DEQ 1999). Since the ROD was issued in 2001, the WQB-7 standards have been updated and are now called *Circular DEQ-7, Montana Numeric Water Quality Standards* (DEQ-7 standards, DEQ 2006). Both the September 1999 WQB-7 standards and the February 2006 DEQ-7 standards (in parentheses) are shown in the tables.] Laboratory analytical reports and chain-of-custody forms for the 2005 monitoring events are provided in Appendix B.

3.3.1 March 2005 Analytical Results

Analytical results for the March 2005 monitoring event are summarized in Tables 10 through 14. Figure 7 shows the distribution of dissolved-phase petroleum hydrocarbons and natural attenuation data for the March 2005 monitoring event.

EPH screen concentrations of 325 and 369 micrograms per liter (µg/L) were detected in the groundwater samples collected from wells L-87-1 and LG-12, respectively (Table 10). (Note: Well L-87-1 is located upgradient of the area in which petroleum hydrocarbon-containing subsurface media related to the Former Depot Refueling Area have been reported. This March 2005 result suggests that groundwater at this location is affected by an upgradient petroleum source unrelated to the Facility.) The two samples collected from wells L-87-1 and LG-12 were further subject to EPH fractionation. No petroleum hydrocarbon fractions were detected in either sample above the method reporting limit. The sample collected from well LG-12 was also analyzed for PAHs (Table 11). Acenaphthene and fluorene were detected in the sample at concentrations of 1.33 and 0.663 µg/L, respectively, which are below the ROD cleanup levels of 420 and 280 µg/L for these compounds. (Note: DEQ-7 standards for these compounds are 670 and 1,100 µg/L, respectively.) No other PAHs were detected above the method reporting limit of 0.100 µg/L.

Naphthalene, the only VPH compound detected, was detected in all the groundwater samples as well as the laboratory method blank samples (Table 12). Due to the detection of naphthalene in the method blank samples, the laboratory reanalyzed all the groundwater samples using EPA Method 8260. Naphthalene was not detected in any of the groundwater samples analyzed using EPA Method 8260 above the reporting limit of 1.00 µg/L, except the sample collected from L-87-6 and the duplicate sample collected from well LG-13. Naphthalene was detected in the sample from L-87-6 and the duplicate sample from well LG-13 at concentrations of 2.13 and 1.20 µg/L, respectively, which are below the ROD cleanup level for naphthalene of 28 µg/L. (Note: The DEQ-7 standard for this compound is 100 µg/L.) The laboratory concluded that the naphthalene

detected using the VPH method was attributable to laboratory contamination of the analytical instrument.

Results of the March 2005 sampling indicate that dissolved-phase petroleum hydrocarbon and PAH concentrations in alluvial aquifer groundwater at the Facility are below ROD cleanup/screening levels. Based on these results and discussions with DEQ, the groundwater monitoring program presented in the *Task G Stage I Remedial Action Plan* (Kennedy/Jenks Consultants 2005e) is designed (1) to confirm that ROD cleanup/screening levels have been met in the Former Depot Refueling Area, and (2) to acquire additional data regarding dissolved-phase petroleum hydrocarbon concentrations in the Former Freight Train Refueling Area to evaluate whether the March 2005 data are consistently reproducible and, if so, the implications of this finding on the planned remedial action(s).

Natural attenuation parameters and general chemistry results are consistent with previous data (where previous data exits) (Table 13). DOC, ethane, and ethene data were collected for the first time during 2005 (Table 14) and have no historical data for comparison. Methane was previously analyzed on a limited basis in 1999 (Table 13). Of the wells sampled in March 2005 for methane, only one well (L-87-2) has been previously sampled. The methane concentration in the sample collected from well L-87-2 has increased from 1.8 to 699 µg/L, indicating that some methogenesis is occurring at this location.

With the exception of naphthalene detected during the VPH analysis (which was attributed to laboratory contamination), no other analytes were detected in the groundwater samples collected pre- and post-purge from well RW-8.

3.3.2 June and November 2005 Analytical Results

In June 2005, groundwater samples from 21 monitoring wells and one domestic well were analyzed for VOCs using EPA Method 524.2 or 8260 (Table 3). The VOC

analytical results are summarized in Table 15. The analytical results and concentration distributions for tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE) are depicted on Figures 8, 9, and 10.

During the June 2005 sampling event a groundwater sample was collected from well L-87-3 using the dedicated bladder pump and then using a peristaltic pump. Both samples were analyzed by EPA Method 8260. The concentrations were slightly lower in the groundwater sample collected using the peristaltic pump.

During the June 2005 monitoring event, DEQ collected split groundwater samples from wells 89-4 and 89-8 for analysis of VOCs by EPA Methods 8260 and 524.2, respectively. Split sampling analytical results are summarized in the following table. Analytical results from the primary sample collected by Kennedy/Jenks Consultants are included in the table for comparison.

Well Designation/ Sampling Event	Sample Date	Volatile Organic Compounds (µg/L) by EPA Method 8260		
		Tetrachloroethene	Trichloroethene	cis-1,2-dichloroethene
89-4				
June 2005 K/J	6/26/2005	70.9	1.18	5.28
June 2005 DEQ	6/26/2005	65	1.1	4.5
Relative Percent Difference (RPD)		8.68	7.02	15.95

Note: Only detected values are shown in table.

The reported concentrations of VOCs in DEQ's split groundwater sample are slightly lower than the reported VOC concentrations in the primary sample. No VOCs were detected in the primary or split groundwater samples collected from well 89-8 using EPA Method 524.2. The analytical laboratory report and chain-of-custody form for DEQ's split groundwater samples is provided in Appendix C.

In November 2005, groundwater samples from 11 monitoring wells and one domestic well were analyzed for VOCs using EPA Method 524.2 or 8260 (Table 3). The VOC

analytical results are summarized in Table 15. The analytical results and concentration distributions for PCE, TCE, and cis-1,2-DCE are depicted on Figures 11, 12, and 13.

Groundwater analytical results for 2005 were consistent with results of previous monitoring events at the Facility (Table 15). Domestic well 12R03 had not been previously sampled. PCE was detected in the groundwater sample collected from this well in November 2005 at a concentration of 38.2 µg/L. This concentration exceeds the ROD cleanup level for PCE of 5 µg/L. PCE concentrations exceeding the ROD cleanup level were detected during both monitoring events in groundwater samples from wells located around and east (downgradient) of the Electric Shop (see Figures 8 and 11). PCE concentrations exceeding the ROD cleanup level ranged from 5.03 to 203 µg/L in 2005. The TCE concentration (5.69 µg/L) in the groundwater sample collected from well 89-3 located in the Electric Shop exceeded the ROD cleanup level of 5 µg/L during the June 2005 monitoring event. The TCE concentration (5.36 µg/L) in the groundwater sample collected from downgradient well L-88-10 also exceeded the ROD cleanup level for TCE during the November 2005 monitoring event. The vinyl chloride concentrations of 2.82 and 1.38 µg/L in the groundwater samples collected from well L-87-2 during the June and November 2005 monitoring events, respectively, exceeded the ROD cleanup level of 0.15 µg/L. (Note: DEQ-7 standard for this compound is 0.2 µg/L.) No other VOCs were detected above ROD cleanup levels during the 2005 groundwater monitoring events.

3.4 QA/QC AND DATA VALIDATION

Field QA/QC procedures included adherence to proper chain-of-custody protocols, collection of field duplicate samples, and use of trip blank samples. Proper chain-of-custody protocols were followed at all times during the March, June, and November 2005 sampling events. NCA received samples intact. The temperatures reported by the laboratory for the coolers containing samples L-87-1, L-87-6, L-88-9, LG-5, LG-13, MW-100, LS-6, LS-10, and HRO-23 for the March 2005 monitoring event and the associated trip blank samples ranged from 0.6 to 1.5 ^{o}C, which is slightly below the

recommended temperature range of 4°C ± 2 °C. The lower cooler temperatures should not have impacted the integrity of the samples.

At least one field duplicate sample was collected during each monitoring event, and one trip blank sample was included in every cooler submitted to the analytical laboratory. The duplicate sample results showed good correlation between the duplicate and original samples results with relative percent differences for each duplicate sample at less than 20 percent. The duplicate sample collected at well LG-13 during the March 2005 monitoring event contained naphthalene (based on the EPA Method 8260) at a concentration slightly above the method reporting limit (i.e., 1.2 µg/L); however, naphthalene was not detected in the original sample. These variances are not uncommon for results near the reporting limit.

Five trip blank samples were submitted to the laboratory during the March 2005 sampling event for VPH analysis. Naphthalene was detected in all the trip blank samples at concentrations ranging from 1.88 to 3.17 µg/L. Naphthalene was also detected in the associated method blank samples (as discussed below). Therefore, NCA reanalyzed all the samples for naphthalene by EPA Method 8260. Naphthalene was not detected in any of the trip blank samples above the method reporting limit of 1.00 µg/L.

During the June 2005 sampling event, three trip blank samples submitted. Methylene chloride was detected in one of the trip blank samples at a concentration below the method reporting limit. A concentration of 0.260J µg/L was reported. Methylene chloride was not detected in any of the associated samples.

During the November 2005, three trip blank samples were submitted to NCA. Xylenes (both o-xylene and m,p-xylene) were detected in one of the trip blank samples at concentrations below the method reporting limits. The o-xylene concentration was 0.270 µg/L, and the m,p-xylene concentration was 0.490 µg/L. Xylene was not detected in any of the associated samples.

Upon receipt of the analytical results, Kennedy/Jenks Consultants conducted a QA/QC review of the data in general accordance with applicable sections of the EPA *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999). The evaluation consisted of reviewing the following:

- Holding times
- Laboratory method blank sample results
- Matrix spike/matrix spike duplicate (MS/MSD) sample results
- Laboratory control sample (LCS) results
- Laboratory duplicate sample results
- Field blind duplicate sample results.

Based on the QA/QC review, data for the March, June, and November 2005 monitoring events generally met requirements for each of the above criteria and are valid and acceptable for use, with the qualifications provided below.

Note: One of the laboratory reports for the June sampling event (data set B5F0740) and the three laboratory reports for the November sampling event (data sets B5K0360, B5K0383, and B5K0411) were amended by the laboratory and resubmitted due to the omission of the analyte 1,1,2-trichloro-1,2,2-trifluorethane. 1,1,2-Trichloro-1,2,2-trifluorethane was reported in the amended reports as a tentatively identified compound (TIC) as the instrument was not calibrated for this specific compound at the time the VOC analysis was performed. In addition, the method reporting limits for the November 2005 EPA Method 8260 data were adjusted by the laboratory to a value of 0.500 µg/L, where appropriate.

3.4.1 March 2005 Data

VPH

All the samples collected during the March 2005 sampling event (including the trip blank samples) were initially analyzed for VPH by the MADEP VPH Method. Naphthalene was detected in all the associated laboratory VPH method blank samples at concentrations ranging from 1.79 to 2.18 µg/L. Due to the naphthalene detection in the method blank samples, NCA reanalyzed all the samples for naphthalene by EPA Method 8260. Except for sample MW-100 (the duplicate sample collected at well LG-13) and the sample collected from L-87-6, naphthalene was not detected in the samples reanalyzed by EPA Method 8260.

PAHs

The PAH analysis for sample LG-12, collected on 9 March 2005, was requested by Kennedy/Jenks Consultants after the analytical holding time for this sample had expired. The sample extract, as well as the associated laboratory QC samples, were analyzed 8 days past the recommended holding time. The reported compounds in sample LG-12, acenaphthene at 1.33 µg/L and fluorene at 0.663 µg/L, should be considered estimated values due to an exceedance of the holding time. (Note: The laboratory submitted an amended laboratory report to include the later requested PAH analytical results.)

The laboratory reported that benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene were detected in the associated PAH laboratory method blank sample. Due to these detections, NCA raised the reporting limit to 0.100 µg/L to reflect the laboratory's standard reporting limits for this analysis. Based on the raised reporting limits, only chrysene was detected in the method blank sample above the reporting limit (0.107 µg/L). Chrysene was not detected in the sample collected from LG-12 above the method reporting limits.

3.4.2 June 2005 Data

VOCs - EPA Method 524.2

- The percent recovery for the VOC surrogate 1,2-DCA-d4 was above the laboratory established control limit for samples from wells L-87-2, L-87-5, and 89-8 and a trip blank sample. Samples from wells L-87-2 and L-87-5 were reanalyzed using EPA Method 8260 as the some of the VOC concentrations exceeded the instrument's calibration range. Results from the EPA Method 8260 analysis were reported for these samples. (Note: The reanalysis of samples L-87-2 and L-87-5 were logged into the laboratory's computer system under a special test code for EPA Method 8260 resulting in lower method reporting limits for these samples.) No analytes were detected in the trip blank sample or the sample from well 89-8. Therefore, the exceedance of the control limit does not affect the validity of the analytical results.

VOCs - EPA Method 8260

- Naphthalene was detected in one of the laboratory method blank samples below the method reporting limit. A concentration of 0.480 µg/L was reported. Naphthalene was not detected in any of the associated samples.

- The VOC matrix spike duplicate analysis for Batch 5F30061 was analyzed 20 minutes outside the 12 hour QC window.

3.4.3 November 2005 Data

VOCs - EPA Method 524.2

- Methylene chloride was detected in one of the laboratory method blank samples below the method reporting limit. A concentration of 0.160 µg/L was reported.

Methylene chloride was also detected in the samples from wells 94-2 and 12R03 at similar concentrations (i.e., 0.170 and 0.120 µg/L, respectively) below the method reporting limit. (Note: Methylene chloride was also detected in the purge water sample). Therefore, the detection of methylene chloride in these samples is likely attributed to laboratory contamination. (Note: Methylene chloride has not been previously detected in samples from well 94-2. Well 12R03 has not been sampled prior to the November 2005 monitoring event.)

VOCs - EPA Method 8260

- Methylene chloride had a low bias in the associated verification standard for samples analyzed in Batch B5K18054 (samples L-88-10, L-87-2, 89-4, 90-3, and 92-2). Methylene chloride was not detected in any of these samples and is not a chemical of concern at the Facility. Also the matrix spike duplicate analysis associated with this batch was analyzed 22 minutes outside the 12 hour QC window. However, these findings do not adversely affect the validity of the analytical results for the purposes of comparison to regulatory standards for water quality.

- m,p-Xylene was detected in one of the laboratory method blank samples below the method reporting limit. A concentration of 0.270 µg/L was reported. m,p-Xylene was also detected in the trip blank sample analyzed with this method blank sample at a concentration below the method reporting limit as discussed previously. m,p-Xylene was not detected in any other associated sample. o-Xylene was detected in the same trip blank sample but was not detected in any associated samples.

- Dichlorodifluoromethane had a low bias and 2,2-dichloropropane had a high bias in the verification standard for Batch B522035. Samples analyzed in this batch included 89-3, MW-100 (the duplicate sample collected at 89-3), 92-1, and a trip blank sample. These compounds were not detected in the above samples and are not considered chemicals of concern at the Facility.

- NCA had to reanalyze the groundwater sample collected from well 92-1 to confirm the estimated PCE results reported in the original analysis. The laboratory noted that the volatile organic analysis (VOA) vial used for the reanalysis had headspace/air bubbles greater than ¼ inch in diameter. However, the presence of headspace/air bubbles does not appear to have adversely affected the validity of the analytical results as the PCE concentration obtained from the reanalysis was within historical ranges for samples collected from this well.

3.5 MONITORING SCHEDULE FOR 2006

Groundwater monitoring schedules are presented in the following remedial action and supplemental work plans that were prepared in 2005 in response to the Spring 2005 SOW:

- *Task F Stage I – Part 1 Remedial Action Plan for VOC-Containing Alluvial Aquifer Groundwater, Burlington Northern Livingston Shop Complex, Livingston, Montana,* prepared by Kennedy/Jenks Consultants dated May 2005 (see Table 6 and Table 7)

- *Task G Stage I Remedial Action Plan for Dissolved Phase Petroleum Hydrocarbons in Groundwater, Burlington Northern Livingston Shop Complex, Livingston, Montana,* prepared by Kennedy/Jenks Consultants dated May 2005 (Table 13 and Table 14)

- *Task L Supplemental Investigation Work Plan for Bedrock Aquifer(s), Burlington Northern Livingston Shop Complex, Livingston, Montana,* prepared by Kennedy/Jenks Consultants dated June 2005 (Table 3 and Table 4).

These plans are currently pending DEQ review and approval. The groundwater monitoring schedules in the plans will be implemented upon DEQ approval. If DEQ approval of the plans is not received prior to June 2006, interim semiannual monitoring will be conducted.

4.0 WELL INVENTORY

In December 2005, Kennedy/Jenks Consultants on behalf of BNSF sent out private well surveys forms to property owners located within the monitoring zone boundary identified on Figure 21 of the *Task F Stage I – Part 1 Remedial Action Plan* (Kennedy/Jenks Consultants 2005d) in response to DEQ's comments letter dated 28 October 2005. DEQ's letter required that BNSF conduct the mailing survey for unregistered wells by 15 December 2005 and provide an updated well inventory by 31 January 2006. On 15 December 2005, a letter was sent by Kennedy/Jenks Consultants on behalf of BNSF notifying DEQ that the mailing had been completed.

On 30 January 2006, the *Private and Public Well Inventory (Revision No. 1)* (Kennedy/Jenks Consultants 2006) was submitted to DEQ. This revision responded to DEQ's comments dated 28 October 2005 and included updates from the periodic (annual) review of various databases used to compile the well survey. Eleven additional wells were identified in the Montana Bureau of Mines and Geology, Groundwater Information Center (GWIC) database since the initial well inventory was submitted in May 2005, and one additional well was identified in the Montana Department of Natural Resources and Conservation (DNRC) database.

No additional wells were identified during the well survey based on completed survey forms received prior to preparation of Revision No. 1; however, some confirmation of existing information was obtained. If new information from the well survey becomes available after submittal of Revision No. 1, it will be incorporated into subsequent revisions of the private and public well inventory that will be prepared under the Spring 2005 SOW and the Livingston SOW.

Since this information has been provided to DEQ under separate cover, the information is not repeated in this Annual Monitoring and Maintenance Report.

5.0 OFFSITE DISPOSAL NOTIFICATIONS, OFFSITE DISPOSAL INFORMATION, AND CONTAINED-IN DECISIONS

5.1 OFFSITE DISPOSAL NOTIFICATIONS

No offsite disposal notifications were submitted to DEQ during 2005.

5.2 OFFSITE DISPOSAL INFORMATION

No media were disposed offsite during 2005.

5.3 CONTAINED-IN DECISIONS

Two contained-in decisions were received from DEQ during 2005 as indicated below. Purge water from the March 2005 and June 2005 was landspread at the Livingston railyard during 2005 at the locations indicated in the following table.

Type of Media (e.g., soil, water)	Date of DEQ's Contained-In Decision	Date of Landspreading	Approximate Weight and/or Volume	Approximate Location of Landspreading
Purge Water (June 2005 semiannual monitoring event)	28 October 2005	14 November 2005	<55 gallons	Adjacent to the Forest Products Building
Purge Water (March 2005 groundwater monitoring event in support of Task G)	23 August 2005	14 November 2005	<55 gallons	Adjacent to the secured MRL waste storage area

Treated purge water from the November 2005 monitoring event is currently stored in the secured C&P Packing Building, pending submittal of a contained-in decision letter to DEQ.

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